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THE CHEMISTRY OF ANESTHETICS[1]

IDIOSYNCRASY has in the past accounted for—serves now to account for—unusual observations in the use of drugs, and perhaps will continue to cover much of our lack of information as to their real therapeutic action, but I am of the opinion that it is a "magic skin."

Sacred, profane and mythological literature abound in incident, fact and fancy, showing that from earliest times man has sought to assuage grief and pain by some means of dulling consciousness. Recourse was had to the inhalation of fumes from various substances, weird incantations, application of drugs, both external and internal, pressure upon important nerves and blood vessels, and the laying on of hands, or animal magnetism. Each has played its part in the mitigation of human ills. It was not until the close of the eighteenth century, however, that modern surgical anesthesia was foreshadowed. Then it was that the discovery of hydrogen, nitrogen, oxygen and nitrous oxide—pneumatic chemistry, as it were—created a field of pneumatic medicine. In 1789, the Pneumatic Institute was founded for the purpose of investigating the "medical powers of factitious airs or gases" and was set up at Clifton by Dr. Beddoes. The immediate idea to be followed out was the treatment of phthisis and other lung troubles by inhalation of various gases. Humphry Davy was assigned the office of superintending the experiments. Davy actually inhaled nitrous oxide, and re-

[1] A lecture delivered at the general meeting of the American Chemical Society, Indianapolis, June 28, 1911.

corded his own sensations and the behavior of others after they had inhaled it.

In 1805, Dr. Warren, of Boston, used "sulphuric ether" on a patient suffering with phthisis, and the year following it was used in attacks of asthma; but Faraday, in 1818, was the first to recognize its value as an anesthetic.

Chloroform was discovered in 1831 independently by Liebig, Soubeiran and Guthrie. It is reported in the *American Journal of Science* for January, 1832, that Dr. Ives, of New Haven, used chloroform in surgery.

In 1828, Girardin read a paper describing surgical anesthesia by means of inhaled gases, but the honor of the discovery of surgical anesthesia has been claimed with more or less acrimonious partizanship for four others, namely, Long, of Jefferson, Ga., who anesthetized a patient with ether in 1841; Wells, of Hartford, Conn., who used nitrous oxide in dentistry in 1844; Morton, a pupil of Wells, used ether instead at the suggestion of Jackson, a chemist, who later claimed to be the real discoverer. Simpson, in 1847, first used ether in midwifery and later chloroform, whose anesthetic properties had been previously described by Flourens. In 1868, Andrews, of Chicago, called attention to the use of oxygen with nitrous oxide to produce a non-asphyxial form of anesthesia. In 1906, Brown, of Cleveland, used a warmed mixture of nitrous oxide and oxygen, followed by ether and chloroform, with great success; and in 1909 Gwathmey, of New York, first used warm moist vapors of pulmonary anesthetics.

I shall not recount the historical data which have to do with other anesthetics, a list of which I have published in the *American Druggist,* as my remarks this morning will be limited to nitrous oxide, ether and chloroform, and these few facts—the results obtained from careful unbiased investigation of the literature and other forms of evidence—are given without elaboration or argument.

The speaker knows of no satisfactory basis of classification of anesthetics, hence those that are to be considered will be taken up in chronological order.

NITROUS OXIDE

In 1772 Priestley first prepared nitrous oxide by reducing NO with moist iron filings. In 1793 Deiman and others prepared the gas by heating NH_4NO_3, essentially the commercial process for its manufacture to-day. It is usually carried out by heating mixed salts, as $NaNO_3$ and $(NH_4)_2SO_4$, $NaNO_3$ and NH_4Cl, etc.[2]

Commercial nitrous oxide is apt to contain these impurities: Cl_2, NO, NO_2, HNO_3, NH_3, HCl, CO_2, O_2, N_2 and rare gases of the air. It is usually purified by passing through solutions of sodium hydroxide, ferrous sulphate and sulphuric acid. Further purification may be accomplished by the formation of a hydrate[3] (N_2O, $6H_2O$) below 0° C. and heating this hydrate, with fractional condensation[4] and subsequent fractional distillation.

Beyond the absence of disturbing impurities, the improved methods of the use of nitrous oxide for anesthetic purposes demand a knowledge of the approximate content of nitrous oxide in the commercial product, as will become apparent later, hence a method for its determination is desirable. Various methods have been proposed, for instance, decomposition into N_2 and O_2, burning with hydrogen, explosion with hydrogen, combustion of

[2] The subject is thoroughly covered in a paper by the speaker and Stevenson, *J. Ind. and Eng. Chem.*, **3**, No. 8.

[3] Villard, *Compt. rend.*, 1894, **118**, 1096.

[4] Stolzenberg, *Ber.*, **43**, 1708.

charcoal with absorption of CO_2 produced, explosion with CO, oxidation of fused mixture of sodium carbonate and Cr_2O_3 and determining the amount of Na_2CrO_4 produced, and absorption in absolute alcohol; and none is satisfactory. There is no good test for N_2O known to me. Dr. Stevenson and the author devised a new method, which gives accurate results in hands skilled in the manipulation of gases. It depends upon passing a definite quantity of the gas over heated copper gauze, after a preliminary treatment to remove oxygen, or compounds which produce copper oxide, from the sample, and then passing hydrogen through the apparatus, absorbing the water formed.

The following table, which is self-explanatory, exhibits the results of our analyses of compressed nitrous oxide as supplied by American manufacturers:

No.	Analysis								
	N_2O	H_2O	CO_2	NH_3	O_2	N_2, etc., by diff.	N_2O by explosion	N_2O by $Cu+CO_2+H_2$	N_2O by $Cu+H_2$
1	99.7	0.13	0	0.006	present	0.16	97.5	99.4	99.7
2	96.6	0.15	0	0.001	present	3.25	95.0	96.2	96.6
3	99.5	0.15	0	0	present	0.35	97.3	99.5	99.5
4	95.9	0.16	present	0	present	3.94	94.1	95.6	95.9

Nitrous oxide which is to be used for anesthesia should contain at least 95 per cent. of N_2O and no solids, liquids, combustible organic matter, chlorine or other oxides of nitrogen. A small amount of carbon dioxide, according to the investigations of Gatch, can have no evil effects. If present, however, the per cent. should be known.

ETHYL ETHER

Experience of expert anesthetists, not accounted for by idiosyncrasy, obtained in the use of ethyl ethers supplied by various manufacturers in numerous surgical cases, furnished one of the motives for my investigations into the chemistry of anesthetics. The standards laid down by the various pharmacopœias of the world are not uniform. In view of that fact alone, a thorough investigation seemed called for. Enquiries addressed to large consumers of the solvent in manufacturing processes adduced further need for satisfactory methods of determining the purity of ethyl ether and of detecting impurities introduced, or proving their absence if eliminated, in the modification of raw products used in its manufacture. The presence of small amounts of substances has oftentimes been the cause of a chemical reaction proceeding in a particular direction by virtue of a so-called "catalytic" or other unknown action. So the presence of even traces of certain substances, as peroxidized compounds, aldehyde, etc., may have caused some reactions to be incorrectly explained, or to follow an unusual, or unaccounted for, route.

Ethyl ether is still made commercially by the historical process of treating alcohol with sulphuric acid, hence the misnomer of "sulphuric ether." Although a number of synthetic processes have been proposed, some of which have been tried out, none has proved a commercial success.[5]

[5] In this connection, reference may be made to the method devised by Fritsche for the preparation of ether free from alcohol. In this method, gas containing ethylene is treated with sulphuric acid (*Z. anal. Chem.*, **36**, 298; U. S. Patent No. 475,640, January 19, 1897), and the ethyl-sulphuric acid so obtained is converted into ether and sulphuric acid by means of water. This process was operated on a commercial scale in this country for some time, but it was reported that the industry was destroyed by the Denatured Alcohol Act (Bull. 92, U. S. Dept. of Commerce and Labor, Bureau of the Census, **1909**, p. 96). It is likely, however, that a similar industry may be revived, as natural gas might serve as a suitable material from which to prepare ether (cf.

The *quality* of ethers on the market depend upon, first, the purity or grade of the alcohol used; and second, secondary reactions which take place not only with impurities in the alcohol, but with ethyl alcohol itself. For example, ethyl ether made from ethyl alcohol denatured with methyl alcohol contained other ethers, as dimethyl oxide or methyl-ethyl ether, not found in the ether made from the old rectified spirit. The liberal interpretation of the Denatured Alcohol Act by our government officials, whereby alcohol denatured by ether itself may now be used, eliminated these substances. Many of the impurities traceable not only to the quality of the raw products used, but the secondary reactions due to their virgin impurities, as variations in temperature, pressure, and other conditions, were removable, and have, in a large measure, been removed or much reduced, by subsequent purification.

The specific gravity of ether intended for anesthesia should not exceed 0.720 at 15° C., providing an ether containing minimum quantities of alcohol and moisture is required; however, an ether which shows a specific gravity of 0.7215 (2 per cent. absolute alcohol), 0.7228 (3 per cent. absolute alcohol), or even 0.724 (4 per cent. absolute alcohol), providing the sole "impurity" is ethyl alcohol, is acceptable for anesthetic purposes according to various pharmacopœias.

In this connection it may be stated that for various reasons a pure ether may be diluted with ethyl alcohol when it is to be used for anesthesia. Impurities then observed may be due in part to the alcohol used in dilution. Practically all ethyl alcohol contains some acetaldehyde.

Ethyl alcohol serves, it is asserted, as a preservative for ether when the latter is properly stored; and small amounts interfere in no way with the application of ether in anesthesia. However, the presence of alcohol is unnecessary except when ether is administered by the "drop method." In this case, the presence of alcohol prevents too rapid volatilization and consequent chilling of the apparatus with which the ether is administered. Some have maintained that pure ethyl ether is unsuitable for anesthesia, but it is a fact that the vapor from ether containing alcohol, when passed through water at 40° C., whereby the alcohol is removed, may be and is being used with great success for anesthesia. The presence of excess moisture should be guarded against in the storage of ether, since ether in contact with water or moist air gives rise to various impurities of an objectionable nature. Thus anesthetic ether of proper grade when prepared may develop impurities to be avoided quite as much as if they had been introduced in the original materials or later produced in the manufacture or added in the preparation for distribution in commerce.

Instances of sophistication have been known, but now they are comparatively rare.

Dr. Davis, of the Johns Hopkins Hospital, has made observations on the temperatures of a number of patients anesthetized with ethyl ether by the "drop method" and by warm vapors of ether. In the former the body temperature dropped 1 to 2° F., and in the latter not more than 0.3° F. in any case.

Ether, when freshly distilled over sodium, possesses a specific gravity of 0.7178 to 0.719 at 15°/4° C.; but if it is not, immediately after its rectification, drawn off into vessels, which are at once sealed and carefully stored, the specific

French Patent 352,687, of 1905, of Lance and Elworthy).

gravity increases in a short time. The purest ether procurable on the market is of 0.718–0.719 specific gravity at 15°, but this absorbs water on exposure to the atmosphere and rises to 0.720–0.721 specific gravity, when it becomes fairly constant.

Since the specific gravity of ether is 0.7178 to 0.719 at 15° C., those requiring ether of 0.720 specific gravity thus allow minimum amounts of water and alcohol. Unless the ether is dried carefully by means of sodium, for example, and is kept constantly dehydrated by storing over such an agent, or great care is taken in storing it after final rectification, it is practically impossible to maintain the specific gravity originally possessed by the ether.

The speaker, assisted by Mr. W. A. Hamor, has conducted an extensive investigation on the changes which occur in ethyl ether during storage, and the experimental data obtained[6] lead to the conclusion that the oxidation of ether in the presence of moisture is productive of a series of complex conversions, initiated, however, by the formation of hydrogen dioxide. The slow combustion of pure ether in the presence of water, and under such conditions as exist when it is improperly stored, would appear to occur in the following stages:

1. The formation of hydrogen dioxide from water and oxygen of the air. This is particularly likely in cases where there is direct exposure to light, and it is more or less activated by contact action.

2. Dissociation of hydrogen dioxide into water and oxygen, which latter then exerts a direct oxidizing action, resulting in the formation of the following: acetic peroxide, acetaldehyde and acetaldehyde peroxide, and eventually acetic acid. The formation of acetic peroxide facilitates a series of oxidations, and by its hydrolysis alone acetic and peracetic acids are formed. The peracetic acid then becomes converted into acetic acid and hydrogen dioxide. Therefore it is reasonable to conclude that a continuous cycle of changes occurs in ether during its oxidation and that such changes result in the simultaneous formation and occurrence of peroxidized compounds, intermediate (aldehyde) and ultimate (acetic acid) resultants.

Our experimental work seems to establish beyond any doubt the fact that ether of anesthetic grade contains peroxidized compounds after exposure to varying temperature conditions and sunlight, in the presence of atmospheric oxygen, for considerable periods of time, especially when it is stored in colorless glass vessels or in badly stoppered tin containers.

Aldehyde is undoubtedly the commonest contaminant of anesthetic ethers, and its presence may account for some of the observations made in practise. It is one of the impurities most likely to be generated by exposing partially filled containers to varying atmospheric conditions for long periods of time. Ether should not be stored in glass vessels for any length of time without being tested for oxidation products before use; and the tin containers should be of such capacity that they need not be opened without being emptied when the ether is employed for anesthetic purposes.

With regard to the acidity of the various anesthetic ethers on the American market, it may be said that none that we have examined contained acids (sulphurous, sulphuric, acetic) in what may be termed injurious amounts, since the amount present never exceeded 0.002 gram of acetic acid per 100 c.c. of the sample in any case. The degree of acidity is liable to vary more or less in both direc-

[6] *J. Ind. and Eng. Chem.*, **3**, Nos. 5 and 6.

tions in short intervals during storage in glass vessels, just as in the case of the oxidation of ether itself. The variations in acidity—theoretical, but not sensible in general—may be due to differences between the rapidity of the oxidation and the saturation of the acids by the bases of the glass. In fact, it should be mentioned here that the nature of the ether container is of vast importance in the light of the oxidation changes which are possible. The extent of the oxidation—or, for that matter, any oxidation at all—is dependent upon the quality of the glass used in bottles for storing ether; and in the case of metallic containers, in view of some recent researches, it is probable that all metals which show anomalous anodic conductivity are likely to develop free hydrogen dioxide in contact with water and oxygen. The presence of such metals should, therefore, be guarded against.

Since it is highly important that ether intended for anesthetic purposes should be carefully manufactured and properly stored, as prolonged exposure to light and air greatly affect the results of etherization, causing coughing, suffocation, and even dangerous after effects, such ether should always be tested for peroxides and aldehyde, and the presence of the latter should be rigorously guarded against, or the ether, if so contaminated, should be administered by a method which eliminates these impurities before it is introduced into the animal system.

We have made an examination as to the value of all proposed tests for the presence of impurities in ethyl ether, and have devised several new and superior ones. A scheme for examination has been worked out and is now available in the literature.[7]

CHLOROFORM

Liebig prepared chloroform from chloral. Soubeiran treated alcohol with "bleaching powder." Schering generated his "bleach" in the presence of alcohol by electrolysis. Then commercial methyl alcohol was used and "methylated spirit," whereby so-called "methylated chloroform" was obtained. Liebig also obtained chloroform by the action of "chloride of lime" upon acetone. Böttger and others used acetates (1848), and then chlorine was liberated in acetone by electrolysis. This process is used extensively in this country now. Methane of natural gas has been burned in chlorine, but this process has not proved successful commercially so far, although "gas chloroform" is spoken of by some in a wise way. Carbon tetrachloride, made by chlorinating carbon disulphide, is being reduced by the process of Smith to produce much chloroform in this country at present. "Chloral chloroform" is imported in small quantities.

From the variety of "Ausgangs-material" and different methods used it is quite evident that crude chloroform may contain a wide range of impurities, which may vary not only with the materials used but also with the conditions of manufacture. Alcohol has been removed from chloroform by washing with water, the chloroform being subsequently dried over calcium chloride. Potassium hydroxide has been used to remove excess chlorine and acids. Manganese dioxide has been employed to remove sulphur dioxide. Chloroform has been shaken with concentrated sulphuric acid until the acid was no longer colored; the vapors of chloroform have been passed through towers of crystallized sodium carbonate after treatment with sulphuric acid, and rectification has followed. To remove special impurities or decomposition products of the chloroform itself, chloroform has been treated with lead dioxide; with potassium permanganate, or

[7] Baskerville and Hamor, *loc. cit.*, **3**, No. 6, p. 395.

with dilute sodium thiosulphate; or it has been distilled over 2 per cent. paraffin or poppy oil. "Chloroform Anschütz" is obtained by distilling from crystals of salicylid-chloroform. "Chloroform Pictet" is made by chilling chloroform to —80° C., filtering off the solids produced, and then lowering the temperature to —82° C. and drawing off the liquid impurities. The frozen chloroform is then fractioned, the intermediate 80 per cent. of the distillate being taken.

The specific gravity values of chloroform have been determined by different workers as follows:[8]

TABLE I. DETERMINATIONS OF THE SPECIFIC GRAVITY OF CHLOROFORM

0°	11.8°	12°	15°	15.5°	16.5°	17°	18°	18.58°	25°	29°	35.86°	60.8°	61.2°	63°
1.52523	1.5039	1.496	1.485	1.500	1.472	1.491	1.48	1.48978	1.48432	1.49089	1.45695	1.4081	1.40877	1.3954
1.52657		1.512	1.4946			1.507			1.48492					1.4018
			1.4905											1.408114
			1.4976											
			1.5066											
			1.5107											
			1.4989											
			1.4980											
			1.500											
			1.50027											
			1.50085											
			1.49887											

In the course of an investigation on the decomposition of chloroform, we prepared *pure* chloroform.[9] This possessed a density of 1.49887 at 15/4° (average of six determinations), a result in close agreement with the values of Thorpe and Timmermans. This value may be taken as the correct specific gravity at the temperature noted.

The anesthetic chloroform on the American market varies in specific gravity from 1.4730 to 1.4827 at 25/25°, usually in close proximity to 1.476, the minimum density permitted by the pharmacopœia. The samples of chloroform of German manufacture examined varied in specific gravity from 1.487 to 1.492 at 15/15°, although one sample possessed a density of 1.497 at this temperature. Since the correct specific gravity of chloroform is 1.49887 at 15/4°, those officials requiring chloroform of a lower density—that is, anesthetic chloroform—allow the addition of alcohol, and consequently the presence of small amounts of water; the permissible addition usually varies from 0.5 to 1 per cent.

Specific gravity determinations are not to be regarded as criteria of purity beyond indicating the amount of alcohol in chloroform.

The boiling points of chloroform according to different observers are as follows:

BOILING POINT OF CHLOROFORM

Year	Observer	Temperature
1883	Schiff	60.9° at 754.3 mm.
1884	Perkin	62.0° at 760 mm.
1885	Bauer	61.0° at 760 mm.
1889	Thayer	61.6° at 760 mm.
1899	Pettit	61.97° at 760 mm.
1904	Wade and Finnemore	61.15° at 760 mm.
1911	Baskerville & Hamor	61.20° at 760 mm.

In general, it may be said that no specific directions are given for the determination of the boiling point and the influence of the variables (alcohol and water

[8] A discussion of these values is given in an elaborate paper on "Chloroform" by the speaker and W. A. Hamor, which will appear in *J. Ind. and Eng. Chem.*, **3**, No. 10.

[9] Baskerville and Hamor, *loc. cit.*

in particular) has not received enough attention. Opinions are divided as to the value of the determination as a criterion of the purity of anesthetic chloroform. In the speaker's opinion, it is of no value without a knowledge of the content of alcohol and water. In making a careful fractionation of 500 g. of anesthetic chloroform made from acetone, containing 0.5 per cent. alcohol and 0.026 per cent. water, but otherwise pure, the temperature rose at once to + 55.5° C., at which point part of the alcohol and water with some chloroform passed over, the remainder of the alcohol with part of the chloroform going over between + 59.4° and + 61°. The following fractions were obtained:

Temperature	Weight of Fraction
55.5–59.4°	10 g.
59.4–61.0°	177 g.
61.0–61.2°	300 g.
Above 61.2°	13 g.

The influence of alcohol and water, separately or together, on the boiling point of chloroform may be seen from the following table.

BOILING POINTS OF MIXTURES OF CHLOROFORM, ALCOHOL AND WATER

Constituent	Boiling Point	Per Cent. Chloroform
1. Chloroform-alcohol-water	55.5°	92.5
2. Chloroform-water	56.1°	97.5
3. Chloroform-alcohol	59.4°	93.0
4. Chloroform	61.2°	100.0
5. Alcohol-water (95.5 per cent. alcohol)	78.15°	
6. Alcohol	78.3°	
7. Water	100.0°	

There has been not a little variety of opinion among chemists as to the nature and products of the decomposition of chloroform, especially the changes which chloroform undergoes upon exposure to air; in fact, this discordance dates from the introduction of chloroform as an anesthetic and prevails to-day. This condition is ascribable to the many influencing factors occasioned by the degree of purity of the chloroform under examination, the extent and nature of the exposure; but is principally due to the failure to consider, and therefrom to correctly interpret, the rôle of the general variable, alcohol, and with it the accompanying moisture.

The products of the decomposition of "pure" chloroform, according to various investigators, may be thus summarized:

Chlorine; hydrochloric acid	Morson; Maisch; Hager.
Carbonyl chloride	Rump; Regnault.
Carbonyl chloride; hydrochloric acid	Stark; Ramsay; Schoorl and Van den Berg; Dott.
Carbonyl chloride; chlorine	Brown; Schacht and Biltz; Adrian.

The formation of carbonyl chloride is alone definitely agreed upon.

The decomposition of chloroform has been universally conceded to be an oxidation process. It is generally accepted that chloroform is unaffected by light alone, and that light, although it accelerates oxidation, is not a necessary factor in the process; however, several investigators appear to have inclined to the view that light favors decomposition.

With regard to the changes which occur in anesthetic chloroform, that is, chloroform containing alcohol, during exposure to air and light, there also exists a decided diversity of opinion, principally owing to the fact that no examinations were made during the course of the various investigations, so far as we are aware, for the presence of the oxidation products of alcohol in such chloroform. The whole subject required investigation, and accordingly an experimental study of the decomposition of both pure and anesthetic chloroform was carried out. It was also hoped to

throw light on, if not fully explain, the rôle of alcohol[10] and other substances in the so-called preservation of chloroform, a satisfactory explanation of which has been wanting.

Various samples, some twenty-three in all, of both pure chloroform[11] and chloroform containing the usual pharmacopœial amounts of alcohol and water, were exposed, in well-stoppered[12] containers of various sizes, and containing varying amounts of the samples, and of both colorless and anactinic glass, such as are customarily used in the trade, for different periods of time, but at room temperature (20° C.), from September to May, inside of a window having direct southern exposure. The conditions were extreme, but nevertheless were similar to those obtaining in many pharmacies and hospitals.

The anesthetic chloroform used was examined prior to the experiments, and only such chloroform as was found to be free from impurities was used. However, an amount of water equivalent, on the average, to 5.1 per cent. by volume of the alcohol present was permitted.[13] Thus each sample was of pharmacopœial grade.

[10] The amounts of alcohol stated as permissible in the various official chloroforms intended for anesthetic purposes are as follows:

Belgium	1.0 per cent.
Denmark	1.0 per cent.
Sweden	0.5–1.0 per cent.
United States	0.6–1.0 per cent.
France	0.005 part by weight.
Italy	0.5 per cent.
Switzerland	1.0 per cent. absolute.

[11] This chloroform was prepared according to the method of Baskerville and Hamor and was absolutely pure.

[12] No cork stoppers unprotected by metal caps were employed. In the experiments on pure chloroform, glass-stoppered bottles were solely used.

[13] The alcohol content of the anesthetic chloroform used was determined quantitatively by the method of Nicloux.

The tests applied for the detection of the oxidation products of chloroform and alcohol were those previously proved out in our work. Quantitative determinations of the impurities developed were made when possible.

The experimental results warranted the following conclusions:

1. The products of the oxidation of *pure* chloroform are carbonyl chloride and hydrochloric acid, which come about according to these reactions:

$$CHCl_3 + H_2O + O_2 = COCl_2 + HCl + H_2O_2;$$
$$CHCl_3 + H_2O_2 = COCl_2 + HCl + H_2O.$$

We are convinced that oxidation will not occur if water be excluded, and the absolute exclusion of moisture appears to be impossible. Hydrogen dioxide is formed, although we have been unable to detect it in chloroform undergoing oxidation, and therefore conclude that its existence is ephemeral, and oxidation of the chloroform continues throughout the period of exposure. The rôle of the water is that of a true chemical catalyst. The decomposition of pure chloroform is accelerated by light, and carbonyl chloride is formed with increased readiness in the presence of acids.[14]

The extent of the oxidation is dependent upon the nature of the container, the amount of air present, the purity of the sample, and the intensity of the light to which it is exposed.

Free chlorine can only result from the photochemical decomposition of carbonyl chloride:[15]

[14] Cf. Lowry and Magson, *Trans. Chem. Soc.*, **93**, 121, who observed that the formation of carbonyl chloride is evidently accelerated by the presence of acids.

[15] In this connection, see Coehn and Decker, *Ber.*, **43**, 130; and Weigert, *Ann. Physik*, 1907, (4), **24**, 55. The influence of light on the reversible reaction, $CO + Cl_2 \rightleftarrows COCl_2$, is purely catalytic.

$$COCl_2 \rightleftarrows CO + Cl_2.$$

It is likely that in the cases where "chlorine" was identified as an indication of incipient alteration of chloroform, hydrogen dioxide was the cause of the reactions observed. No chlorine was found when containers of anactinic glass were used; and when chlorine is detected, it must be the result of a secondary reaction.

2. The products of the oxidation of anesthetic chloroform are primarily the oxidation products of alcohol, and no decomposition of chloroform itself occurs while the oxidation of alcohol proceeds. When the oxidation of alcohol reaches a maximum, decomposition of the chloroform goes on, as in the case of pure chloroform, with the exception that chlorinated derivatives of the oxidation products of alcohol may result. The decomposition of the chloroform itself is retarded, even prevented, so long as oxidation of the alcohol proceeds, and the retardation is consequently dependent upon the amount of alcohol present.

This leads to the rôle played by ethyl alcohol in the preservation of chloroform, for alcohol does prevent the decomposition of chloroform, as first suggested by Squibb in 1857 and later (1863) by Brown, independently.

Those who have investigated the part played by alcohol in preserving chloroform up to the present time have held that either chloroform decomposes in the presence of alcohol and that the alcohol takes care of the decomposition products or the alcohol acts as a "catalytic retarding agent" (Stadlmayr).

The preservative action of alcohol is due to the combination of the retarder with certain of the reacting substances; and any substance soluble in chloroform and readily oxidizable will exert an inhibitory effect on the oxidation of chloroform itself; for example, sulphur and many other substances.[16] All compounds which have been found to serve as preservatives of chloroform are reducing agents, and the effect is only due to their capacity for oxidation.

Anesthetic chloroform should preferably be furnished in vials or bottles of high-grade anactinic glass,[17] containing about the quantity sufficient for one narcosis, and at the most not more than can be used within several days. If, for any particular reason, chloroform is ordered in a large container, it is advisable, immediately after opening it, to subdivide the entire remaining contents into two-ounce bottles, taking care to fill the small bottles completely. It is important to see that the bottles are completely free from water, and empty bottles should not be refilled without thoroughly cleansing and drying them. In no case should chloroform be gradually withdrawn in small quantities from large bottles or carboys. When it is found necessary to store anesthetic chloroform, it should always be kept in a cool, dark place, in well filled, or, better still, completely filled, tightly stoppered bottles of anactinic glass.

The condition of officinal chloroforms which may be transported across the ocean and continent or kept at sea for variable lengths of time, where they would be subjected to constant agitation, has been investigated. Anesthetic chloroform in unopened, brown glass bottles were subjected

[16] Paper by Baskerville and Hamor, *loc. cit.*

[17] The glass should show no alkaline reaction when the bottle is filled with distilled water containing several drops of phenolphthalein solution and heated at 100° C. for six hours. On the action of alkalies on chloroform, see Berthelot, *Bull. soc. chim.*, (2), **29**, 4; Andre, *Compt. rend.*, **102**, 553; de St. Martin, *ibid.*, **106**, 492; and Mossler, *Monatsh.*, **29**, 573. It appears to be well established that potassium hydroxide in alcoholic solution will slowly decompose chloroform.

to intermittent agitation for over 200 hours in a Spiegelberg shaking apparatus, and it was learned from four samples so treated that it is desirable to prevent the presence of air, *i. e.*, oxygen, being in association with this anesthetic when it is to be shipped in the usual manner. Monneyrat devised a method of displacing air by nitrogen, even making a nitrogen siphon of chloroform.

The keeping qualities of anesthetic chloroform may be seriously affected by the character of containers. The question of keeping anesthetic chloroform in tin containers has been a much agitated one in the Federal War Department, and within the last ten years this department has decided in favor of the tin container.

The opinion of the author is that glass containers are more conducive to purity for several reasons. First, in cleaning the vessels any foreign matters present may be readily observed and the bottles properly cleaned. Second, in the case of tins, some of the flux used in soldering may be introduced and thus impart an acid reaction to the chloroform. Hydrochloric acid accelerates the decomposition of chloroform. The introduction of this flux is also a problem in ether manufacture which requires the utmost care. Third, since it has been stated that spirit containing 95 to 96 per cent. by volume of ethyl alcohol is perfectly indifferent to tin, and tinned metals are absolutely unattacked by 90 per cent. denatured spirit, the tinned metals only being corroded where the tin layer is broken,[18] one would conclude that acid-free chloroform,[19] containing the usual amounts of alcohol and water, would also be without action on tin, providing it is stored in tin containers having no broken or scratched surface, very carefully capped, and with a minimum amount of air. In order to determine this, a five-pound sample of chloroform, containing 0.84 per cent. by volume of absolute alcohol and approximately 0.05 per cent. of water, which had been stored in a tin container, sealed, for sixteen months, was examined for the presence of tin. This sample left a residue non-volatile at 100° C., amounting to 0.0220 g. per liter, but none remained upon ignition and no tin could be detected in the sample. The examination of a sample of anesthetic chloroform which had been kept in a sealed tin for six years also showed that no tin had been dissolved. In both cases, however, oxidation of the alcohol present had occurred, although no decomposition products of chloroform were present.

Fourth, we have been informed by H. H. Dow[20] that he has "demonstrated that moist chloroform in the presence of a metal will slowly form traces of CH_2Cl_2 and probably . . . that it is possible to distil pure, dry chloroform in a metal container and produce a decomposition as shown by the following formula:

$$4CHCl_3 + Cu_2 = C_2Cl_6 + 2CH_2Cl_2 + Cu_2Cl_2.$$

This reaction, however, takes place so slowly that it would never be noticed except in the handling of a material on which superlative efforts have been expended for years in order to get the last extreme of purity." Moreover, "all chloroform contains traces of CH_2Cl_2." In this connection, it should also be mentioned that it is probable that all metals which show anomalous anodic conductivity

[18] Heinzelmann, *Z. Spiritusind.*, **27**, 399. Malmejac, however (*J. Pharm. Chim.*, 1901, **13**, 169), found that a small amount of tin goes into solution in 95° alcohol after six months.

[19] On the action of hydrochloric acid in chloroform on tin, see Patten, *J. Physical Chem.*, **7**, 161, who found that the dry solutions act upon the metal less violently than upon zinc or aluminum, but more violently than on lead.

[20] Private communication.

are likely to develop free hydrogen dioxide in contact with water and oxygen;[21] in the speaker's opinion the presence of such metals should therefore be guarded against in the selection of a container for anesthetic chloroform.[22]

The *Pharmacopœia of the United States* formerly required the use of "glass-stoppered" bottles, but subsequently changed this to "well-stoppered" bottles, thus allowing the use of cork stoppers, a practise which has become general in this country.[23]

The objections which have been urged against the employment of cork stoppers are two in number. First, the chloroform penetrates the cork after some time, especially during the agitation incidental to shipment, causing shrinkage and perhaps consequent leakage.[24]

The second objection is that organic matter is extracted from the cork and the chloroform fails when the sulphuric acid test, a test used for the detection of fusel oil, chlorinated decomposition products, etc., is applied. To obviate these difficulties, certain manufacturers of chloroform have adopted the plan of covering the bottom of corks with tin foil, a procedure which so far has been found to be satisfactory, but which may be open to some of the objections to tin containers. Other manufacturers use a paper or parchment covering, and still others select only the best corks and extract them thoroughly with chloroform before use.

The impurities which anesthetic chloroform brings with it from the manufacturer, the so-called "organic impurities," are traceable to the materials used in the making, method of manufacturing, subsequent purification, and manipulation before marketing; these may be grouped into one class (A). Another class (B) includes those impurities developed during different conditions of storage.

These impurities, even though some may not be of much importance from a physiological standpoint, must still be given attention, since an impure chloroform is more likely to become altered through oxidation during storage, notwithstanding the fact that pure ethyl alcohol has been added. So far as we have been able to learn, the adulteration of anesthetic chloroform is not practised now, and crude chloroform is no longer sold as chloroform of anesthetic grade.

You are spared a discussion of the numerous tests for the various impurities which may be present in anesthetic chloroform, as these will soon be available in one of our papers. Suffice it to say that in our laboratory we have studied every test we have been able to find in the literature and have been forced to devise new ones in some cases, while in others we are unable to make any recommendations at all as

[21] Barnes and Shearer, *J. Physical Chem.*, **12**, 155, 468.

[22] All of the manufacturers of chloroform in this country use brown glass ("anactinic") bottles. Of the eight different makes of German chloroform examined by the speaker, only two were contained in colorless bottles.

[23] In Germany, however, glass stoppered bottles are used by prominent producers of anesthetic chloroform (Kahlbaum; de Haen; Merck; "A.-G. für Anilin-Fabrikation," etc.).

[24] Allain [*J. Pharm. Chim.*, (3), **9**, 571] and Masson [*Ibid.*, (6), **9**, 568] have recommended that when chloroform is kept in cork-stoppered bottles, a lute of "bichromate gelatin" should be used to prevent leakage. This is unnecessary when a proper stopper is used, and the employment of lutings on the stoppers has led to many differences between the manufacturer and consumer in the past. Only one of the many samples of anesthetic chloroform examined by the authors was contained in a bottle having a luted cork stopper, and in this case considerable organic matter had been taken up, and, as a result, the chloroform failed to comply with the important sulphuric acid test or confused its interpretation.

yet. Two illustrations may prove of interest. Paraffin oil, sp. gr. 0.88, may be used to discriminate between 0.08 and 0.09 per cent. of water in chloroform, but it does not show the presence of a smaller amount. We were not aware of any test having been devised to show the presence of less than 0.05 per cent. of water in chloroform until we found that clean crystals of calcium carbide would answer most satisfactorily.

Carbon tetrachloride boils at + 78.1° C. and has a specific gravity of 1.63; chloroform boils at + 61.2° C. and has a specific gravity of 1.4989. A binary mixture containing 7.8 per cent. carbon tetrachloride boils at + 62° C. From what has been said of the presence of the variables, alcohol and water, in anesthetic chloroform and their influence upon the physical properties of chloroform, it will be quite evident that determinations of these physical constants can be of little real value, and their application in general practise, even in well equipped laboratories, is quite out of the question. All our efforts to secure a method applicable on a laboratory scale to detect likely amounts of carbon tetrachloride in chloroform have been unsuccessful. To be sure carbon tetrachloride possesses anesthetic properties, but it must exert its own specific physiological effect and the anesthetist should know the drug he uses.

Among the anesthetic mixtures, the combination of chloroform vapor with oxygen was used shortly after the introduction of chloroform as an anesthetic, and it has recently been reintroduced into practise. Hence it was important to investigate the changes which anesthetic chloroform undergoes when a current of oxygen is conducted through it. Dr. J. T. Gwathmey[25] has recently stated that oxygen increases the value of all inhalation anesthetics as regards life.

Several experiments were carried out in order to determine whether the passage of a current of oxygen through anesthetic chloroform brings about decomposition of the anesthetic. Anesthetic chloroforms containing 0.56 to 1.0 per cent. of alcohol and 0.03 to 0.05 per cent. of water were used. The conditions were such, except that the temperature was about + 20° C., as obtain during administration by the Gwathmey method, his apparatus being used. The oxygen was allowed to flow at such rates through 3½ to 4 ounces of the anesthetic that about one-half remained in the vaporizer after 3½ to 10½ hours. In one experiment the chloroform vapor was passed through water, as is Dr. Gwathmey's practise, and subsequently condensed. The examination of the residue and condensed chloroform showed the following:

Acidity (acetic acid):	
Chloroform used	None.
Residue in container ...	0.00015 g. in 100 c.c.
Condensed chloroform ..	None.
Sulphuric acid test:	
Chloroform used	Negative.
Residue in container ...	Marked reaction.
Condensed chloroform ..	Negative.

Therefore it was concluded that the oxidation products of alcohol are not carried over when the chloroform-oxygen stream is conducted through water, and that these are concentrated in the residue. By this method of administration the patient is protected from the objectionable decomposition products even if they had developed. Furthermore, the vapors of the anesthetic so applied are saturated with water, hence can not exert that desiccating effect upon the mucous membranes they would if not moisture-laden.

[25] The speaker has been collaborating with Dr. Gwathmey, who has directed the clinical observations.

OXYGEN

As animadverted, ninety-four years after the discovery of nitrous oxide and oxygen by Priestley, they were first used in combination for anesthetic purposes. Although Andrews published accounts of several cases, in which, by mixing oxygen with nitrous oxide, he had obtained a more satisfactory form of anesthesia than with nitrous oxide alone, his observations failed to attract the attention they deserved. Ten years later (1878) Paul Bert drew further attention to this form of anesthesia. Hewitt[26] stated previous to the completion of the work reported this morning, that the most recent and best development in modern anesthetics is the combination of oxygen with nitrous oxide whereby a non-asphyxial and safe form of anesthesia may be produced. The results of a long series of experiments with various anesthetics and different mixtures caused Gwathmey to say "Oxygen is indicated with every anesthetic and at all times. The longer the anesthesia, the more urgent is the call for oxygen by the blood." The importance of the quality of the oxygen is apparent.

At the present time, there are the following methods of preparation and manufacture of oxygen:[27] (1) heating chlorates; (2) heating chlorates with various substances; (3) from hypochlorites and reaction of chlorine and water; (4) heating sulphuric acid or sulphates; (5) heating various solids and mixtures (MnO_2, CuB_4O_7, etc.); (6) combustion of solid mixtures (chlorates with combustible material, alkaline peroxides with hydrated salts, etc.); (7) reaction of peroxides (oxone) with water and aqueous solutions; (8) by electrolysis of water; (9) from the air by means of mercury, cuprous chloride, barium dioxide, manganates, plumbates, or living matter, or by dialysis or absorption; and (10) from liquid air.

Oxygen that is to be used in anesthesia should contain at least 95 per cent. O_2 upon the dry basis. We found that the pyrogallate method is the most convenient method to employ and most satisfactory, provided Hempel's[28] precautions to prevent the production of carbon monoxide are taken.[29]

Analyses, by our methods, of oxygen on the American market gave the following results:

No.	Source of Oxygen	O_2	H_2O	CO_2	H_2	Organic Matter	N_2, etc.	All other Impurities
1	$KClO_3+MnO_2$	93.20	0.30	0.11	0	0	6.39	0
2	$KClO_3+MnO_2$	98.31	0.14	present	0	0	1.54	0
3	$KClO_3+MnO_2$	92.82	0.26	trace	0	0	6.92	0
4	$KClO_3+MnO_2$	97.13	0.23	present	0	trace	2.63	0
5	Liquid air	96.10	0.15	0.01	0	0	3.74	0
6	Electrolysis	99.23	0.35	0.03	0.14	0	0.25	0
7	$Na_2O_2+H_2O$	99.20	0.50	trace	0	0	0.30	0

CONCLUSIONS

I realize the danger of a mere chemist making an excursion into the field of medicine, but the extremely venturous one, if he has luck, may be swept by the rocks of which he knows little. I ventured in, as I was unhampered by tradition, and I have done enough in this field to make me take a theoretical plunge.

Modern studies in physiology have unquestionably shown that the animal body exists to a great extent by virtue of the chemical and physical changes going on within it. I know of no valid reason for assuming

[26] "Anæsthetics," The Macmillan Co.

[27] Baskerville and Stevenson, *J. Ind. and Eng. Chem.*, **3**, 471.

[28] Hempel, "Gas Analysis," English translation by Dennis, 1906, p. 149.

[29] Commercial oxygen as supplied in the trade has been quite thoroughly investigated by the speaker and Stevenson, *loc. cit.*

that these changes are essentially different from those we control in the laboratory. If we wish to control a physical or chemical change in the laboratory, we endeavor to become familiar with all the factors and conditions. If we seek to duplicate, we try to duplicate the conditions. I know of only one class of such changes over which we have not as yet secured control, and in that class belongs those processes which we term radioactive. One of the essential factors in controlling a chemical process is the quality of the material with which we are working. I can not, therefore, but regard all published statistics as to the mortality attributed directly to the anesthetic used as more or less worthless, and that a large number of new cases must be observed to secure knowledge of the real physiological effect of the drug when carried into the system by the pulmonary route.

Impure foods, sophisticated intentionally or otherwise, may bring on disease. Impure drugs, concocted or otherwise, fail to produce the full effect planned by the physician in curing disease.

Idiosyncrasy has served to account in large part for untoward after-effects of anesthetics and certain disagreeable consequences, as nausea; and interference with some normal organic functions, as glycosuria and albuminuria, have often been regarded as natural results of anesthesia, and taken for granted. They may now be largely obviated and in many cases entirely avoided by the use of anesthetics that are free from impurities, and by improved methods of administration. These statements are based upon clinical evidence. We now have records of 5,000 cases.

The main objectionable impurity in ether is acetaldehyde. American official ethers call for three to four per cent. of ethyl alcohol in accordance with an old and erroneous theory that alcohol protected the ether. Alcohol is practically never free from water, and in the presence of water and oxygen forms oxidation products. The speeds of the changes depend upon conditions. It has been shown that the administration of moist ether, free from aldehyde, at body temperature, is rarely followed by nausea (less than ten per cent.) and the usual strain upon the kidneys is not observed.

Chloroform was formerly made mainly from alcohol and contained many of the normal impurities of the alcohol used. These were not removed by the methods of purification practised, nor are they totally removable, except by elaborate methods of purification. These impurities doubtless have had much to do with the feeling of uncertainty in administering chloroform. Pure chloroform undergoes decomposition when exposed under certain conditions, such, for example, as the manner in which anesthetic chloroform is dispensed in some drug stores and hospitals. A suitable amount of alcohol prevents this decomposition, shunting the change in composition to itself, hence anesthetic chloroform should contain ethyl alcohol. But the conditions of transportation and keeping of this chloroform should be such as to reduce the change of alcohol to aldehyde and acetic acid to the minimum.

Nitrous oxide, ether and chloroform, each exerts its specific physiologic effect in producing anesthesia without asphyxiation, provided the respiratory and cardiac functions are approximately normal. This may be and is being accomplished by administering these gasified drugs with sufficient oxygen not to interfere seriously with the normal function of the hæmoglobin of carrying oxygen to the capillaries and sustaining cardiac stimulation, and by maintaining the usual concentra-

tion of carbon dioxide in, and providing its regular elimination from, the blood; for it is the respiratory stimulant (Yandall Henderson). Other factors involved are temperature and moisture. The anesthetics are carried into the system at body temperature. This may be and is being accomplished by warming, and, in the case of ether and anesthetic chloroform, by passing the vapor through heated water, which, at body temperature, not only removes the oxidation products, but saturates the gas with moisture (Gwathmey method). The osmotic action of the alveolar cells is thus affected only to the extent of the densities of the gases introduced into the lungs, and not, as normally is the case, by temperature (always lower) and desiccation as well. In other words, by the application of the principles of modern physical chemistry, the numerous variables are so reduced as to secure the real physiological effect of the particular anesthetic drug after it enters the system. Nitrous oxide and oxygen may be used for prolonged anesthesia and successfully for eighty per cent. of surgical cases; furthermore, ether and chloroform may be used with equal safety. The real, and no suppositious, idiosyncrasy of the patient may be met. The expert anesthetist may now not only make it possible for the surgeon to perform even greater miracles, but with more comfort to himself in his work, and with greater happiness and less discomfort to the patient.

Charles Baskerville
College of the City of New York

Cyrus Guernsey Pringle

In 1882 I had the pleasure of accompanying Dr. C. C. Parry and C. G. Pringle on a botanical expedition into Lower California. At this time Mr. Pringle was engaged in forming the Jesup collection of American woods for the American Museum of Natural History, and this was his first trip into Mexican territory, as it was my first.

The personal instruction given me at this time, and many following favors in after years, cemented our friendship. Previous to this time Mr. Pringle was principally known as the originator of the snowflake potato, and of new varieties of wheat and oats, and his labors in this field have added many millions to the profits of the American farmer. To him Luther Burbank owes the first training that he received in originating new varieties of plants, and many others could no doubt testify to the helpfulness of the man, ever above the petty jealousies that beset some lives.

The next twenty years passed without my again meeting the man in person, when we met in Mexico City, and I journeyed with him into many fields of botanical interest—the lava fields near that city, and to the grand barrancas near Guadalajara—replete with discoveries which render his name inseparable from the annals of American botany.

Mr. Pringle carried consideration for others almost to an extreme (were this truly possible), and I have seen him select the heavier burden and give his peon servant the lighter one to carry.

In asking for data concerning his life I received the following reply: "I decided that it was hardly possible for me to comply with your request. It would be too painful to write my autobiography. Shyness has become habitual with me. Besides my aversion to publicity, I am too busy to write much. All my thought and labor goes to the building of a great and superior herbarium."

His choice of a monument is the herbarium of the University of Vermont, which bears his name. His death from pneumonia, on May 26, 1911, aged seventy-three years, was announced in the daily press.

A rich man—who has created millions—not for himself, but for his fellow man.

C. R. Orcutt

STUDENTS IN THE GERMAN UNIVERSITIES[1]

SINCE the establishment of the empire the number of students at the German universities has regularly risen from about 13,000 until in the middle of the 80's it had already doubled and the threatened overcrowding of academic pursuits was recognized. The German student body tripled its original number by 1904, and reached in the current summer 57,230 as compared with 54,847 in the previous year. Of the entire number of students to-day 54,678 are men, 2,552 women; of these at present about 53,000 belong to the empire and about 4,300 are foreigners. A comparison of the figures for the different departments for the present and previous year and for 1906 shows what changes in the direction of studies have occurred in consequence of the influence of the needs of the state and society and especially what occupations are favored. In this respect the rapid growth of medicine as a profession is striking, the number of medical students rising from 6,683 in 1906 to 10,682 last year and now to 11,927. Nearest to them stand the students of philosophy, philology and history who number at present 16,158 as compared with 15,475 and 10,832; mathematics and natural science, 8,442 (last year 7,937, in 1906, 6,323); law, 11,023 (11,323 and 12,375); evangelical theology, 2,825 (2,507 and 2,329); of catholic theology, 1,834 (1,840 and 1,841); political economy and agriculture, 2,729 (2,406 and 1,801); pharmacy, 916 (1,147 and 1,767); dentistry, 1,046 (1,264 and 755); forestry—only matriculated in Munich, Tübingen and Giessen, 170 (123 and 114), and of veterinary surgery—only matriculated in Giessen 160 (141 and 114). According to this the number of law students has diminished in consequence of the overfilling of the profession and this is still more the case with pharmacy. The recent reduction in the number of dental students is to be attributed to raising the entrance requirements and the lengthening and increase in cost of the course.

Of the present student body 28,981 are enrolled at the ten Prussian universities as compared with 27,577 in the summer of 1910. At the three Bavarian there are 9,445, last year, 9,369; at the two Baden, 5,532 (1910, 5,279), and in the other six state schools, including the imperial at Strasburg, there are 13,222 as compared with 12,602 in 1910. The university of the metropolis stands at the head, having at present 8,039 students, including 695 women, as compared with 7,902 and 626 last year.

All the universities except Giessen have gained this year, most markedly Greifswald, Kiel, Rostock and Halle, and least, Heidelberg, Münster and the three Bavarian universities.

[1] From the *Journal* of the American Medical Association.

THE ASTRONOMICAL FELLOWSHIP OF THE NANTUCKET MARIA MITCHELL ASSOCIATION

THE Nantucket Maria Mitchell Association offers an astronomical fellowship of one thousand dollars, to a woman, for the year beginning June 15, 1912, under the following conditions: The year shall be divided into two periods, approximately as follows: June 15 to December 15 on Nantucket, where the observatory is equipped with a five inch Alvan Clark telescope. This period shall be occupied in observation, research or study, and in lectures or instruction to classes or individuals. February 1 to June 15 at one of the larger observatories. This semester shall be occupied in original research and study. During this period a distinct plan for the following Nantucket period shall be formulated. Every fourth year the fellowship shall be available during the entire year for study at one of the larger observatories in Europe or America. The fellowship will be awarded annually, but in order that the work at Nantucket may be combined advantageously with the work at the selected observatory, the preference will be given to the same candidate for three successive years. This candidate shall have first consideration among applicants for the special quadrennial appointment. A competitive examination will not be held. The

candidate must present evidence of qualifications under the following heads: (1) A letter from the candidate addressed to the secretary of the committee, giving an account of previous educational opportunities and training, and of plans for future work. (2) College diploma or a certificate from the registrar of her college, and if she has already held a position as instructor or teacher in any college or other institution, a clear statement of the work done, together with a certificate as to the quality of work. (3) Examples of work already accomplished. (4) Testimonials as to ability and character. (5) Satisfactory evidence of thoroughly good health. The fellowship at all times must be used for purposes of serious study, and the fellow should be as free as possible from other responsibilities.

Application for the year beginning June 15, 1912, should be made under the above heads, and must be in the hands of the secretary of the committee, Mrs. Charles S. Hinchman, 3635 Chestnut Street, Philadelphia, Pa., on or before March 1, 1912. The committee consists of Professor Mary W. Whitney, director of Vassar College Observatory, *chairman;* Annie J. Cannon, A.M., Harvard Observatory, *vice-chairman;* Professor Anne S. Young, Ph.D., Mt. Holyoke Observatory; Dr. Edward C. Pickering, director of Harvard Observatory; Elizabeth R. Coffin, A.B., Vassar College, '70; Florence M. Cushing, A.B., Vassar College, '74; Lydia S. Hinchman, Philadelphia, *secretary.*

SCIENTIFIC NOTES AND NEWS

The Vienna Academy of Sciences has elected as honorary members Professor Svante Arrhenius, of Stockholm; Professor Archibald Geikie, of London, and Professor E. Metchnikoff, of Paris.

Professor E. Cosserat, director of the observatory at Toulouse, has been elected a corresponding member of the Paris Academy of Sciences.

The Paris Academy of Medicine has elected as national associates Dr. de Brun, professor of pathology at Beirut, and Dr. Herrgott, professor of clinical obstetrics at Nancy.

The celebration of the seventieth birthday of the Königsberg pharmacologist, Professor Jaffé, took place on July 25.

The Middlemore prize of the British Medical Association has been presented to Mr. C. W. G. Bryan in recognition of his essay on serum and vaccine therapy, in connection with disease of the eye.

Mr. Harlan I. Smith, of the American Museum of Natural History, has been appointed archeologist of the Geological Survey of Canada, with an office in the Victoria Memorial Museum, the national museum of Canada, at Ottawa.

At the recent meeting of the American Ophthalmologic Society at New London, Dr. Edward Jackson, of Denver, was elected president.

The following honorary degrees were conferred at the ninety-first commencement of Colgate University: L.H.D. on John Burroughs, the naturalist; Sc.D. on H. E. Slaught, Ph.D., professor of mathematics, University of Chicago, and John B. Ekeley, Ph.D., professor of chemistry, University of Colorado.

The Dutch geologist, Dr. Molengraaf, has lately undertaken an investigation of the interior of Timor.

The eighteenth Congress of Americanists will be held next year in London, the invitation issued by the Royal Anthropological Institute, through its president, Mr. A. P. Maudslay, having been accepted by the congress. The president-elect is Sir Clements Markham.

The fourteenth annual session of the American Mining Congress is called to meet at Chicago, Ill., on September 26, 27, 28 and 29.

The Michigan Health Board of Exhibit started on its first trip over the state on August 1, promulgating facts regarding typhoid fever, tuberculosis, infant mortality and general sanitation to the people of the state.

By the will of the late Dr. J. Smith, of Hanover, Pa., he devised his entire estate,

valued at about $50,000, toward the endowment of a library for Hanover. A citizen of the town has given a building, which is just completed and the local physicians have undertaken to develop a medical reference section as a memorial to Dr. Smith.

THE *Scottish Geographical Magazine* states that the annual relief of the observers located at Laurie Island, South Orkneys, was effected early in February by the *Uruguay*, which experienced very heavy weather, both on the outward and homeward voyage. The observers report a very open autumn and winter as having occurred last year—May, June and July being all milder than any noted previously. The first zero temperature was not observed till July 24, or three months later than in 1903, when the *Scotia* was frozen in by the end of March. In 1910 Scotia Bay remained unfrozen till the last week of July, being the latest date observed, and broke up on November 18. August was a cold month. During the summer of 1910–11 there was much pack ice round the islands, which did not disperse till early in February, a few days before the arrival of the relief ship. Mr. Elliston, a Norwegian, one of the meteorological observers, died on August 20 of a cardiac complaint after a few weeks' illness.

THE president of the British local government board has, as we learn from the *Journal* of the American Medical Association, authorized the following special researches to be paid for out of the annual grant voted by parliament in aid of scientific investigations concerning the causes and processes of disease: (1) A research into the causes of premature arterial degeneration in man, by Dr. F. W. Andrewes, pathologist to St. Bartholomew's Hospital; (2) an inquiry by Dr. J. H. Thursfield, of St. Bartholomew's Hospital into the causes of death in measles; (3) a comparison by Professor Nuttall, F.R.S., Quick professor of biology at the University of Cambridge, of the number and kinds of fleas found on rats; (4) a continuation by Dr. C. J. Lewis, of Birmingham University, of his investigation into the degree of prevalence and the characteristics of microorganisms known as non-lactose fermenters in the alimentary canal of infants; (5) an investigation into the same subject by Dr. D. M. Alexander, of Liverpool University; (6) an inquiry by Dr. Graham Smith, of Cambridge University into the incidence of non-lactose fermenters in flies in normal surroundings and in surroundings associated with epidemic diarrhœa; (7) a study by Dr. F. A. Bainbridge, of the Lister Institute, of the anaerobic bacteria in the alimentary canal of infants; (8) an investigation by Dr. Graham Smith into the possibility of pathogenic microorganisms being taken up by the larva and subsequently distributed by the fly.

WE learn from *Nature* that the organizing committee of the fourth International Conference of Genetics, to be held in Paris on September 18–23, met recently under the presidency of Dr. Viger. M. Philippe de Vilmorin, secretary of the committee, reported what had been done up to that day in preparation for the conference. Not counting the names of the principal French biologists who are members of the committee, the secretary was able to give the names of the following foreigners who have subscribed: Baur, Giesenhagen, Goldschmidt, Pfitzer, Poll, etc. (for Germany); Agar, Bateson, Darbishire, Gregory, Miss Durham, Hartog, Laxton, Lynch, Nettleship, Paton, Punnett, Miss Saunders, Staples-Browne, Sutton, Miss Wheldale, etc. (for Great Britain); Bradley (for Australia); Fruwirth, Strakosh, Tchermak, etc. (for Austria); W. and Chs. Saunders (for Canada); Johannsen (Denmark); Balls (Egypt); Davenport, Hays, Howard, Swingle, Tower, etc. (United States); Hagedoorn, Houwink, Lotsy, Noordnijn (for Holland); Leake (for India); Strampeli (for Italy); Nilsson-Ehle, Rosenberg (for Sweden); Chodat (Switzerland); Boris de Fedtschenko (Russia), and Arechavaleta (Uruguay). Many universities and scientific societies will be officially represented. Numerous communications have been promised; short descriptions of them will be published before the meeting of the conference, and they will be published in full in the proceedings, a copy of which will be sent to

each subscriber. The meetings of the conference will depend upon the number of the communications, but it seems probable that five sittings will be sufficient. The remaining time will be devoted to visits to the Museum of Natural History, the Pasteur Institute at Garches, to Verrières, the laboratories of the Sorbonne, etc. Probably there will be a reception by the French National Society of Horticulture on September 18, and one at the Hôtel de Ville on September 23.

When congress, in order to encourage the building of the great transcontinental railroads, subsidized them by land grants of enormous areas along the lines to be built, certain restrictions were made as to the character of lands which were thus granted. Thus the land grant of the Northern Pacific excepted all mineral lands other than those containing coal and iron, these minerals being excepted because they would be of use in the building and maintenance of the road. After the grant was made it became necessary to determine what parts of these lands were mineral and should therefore be retained by the government. A classification of the lands included within the Northern Pacific grant in the Bozeman, Helena and Missoula land districts, in Montana and in the Cœur d'Alene district, in Idaho, was accordingly required by the Act of Congress of February 26, 1895, which provided that the classifications should be made by three commissioners in each land district. In the sundry civil Act of June 25, 1910, an appropriation of $30,000 was made to enable the commissioner of the General Land Office to complete the examination and classification of lands within the Northern Pacific grant in this territory. The additional classification was made by geologists of the Geological Survey. As a result of the work done 288,545 acres were examined and classified during the year. Of this area 112,514 acres were classified as non-mineral and may therefore properly be patented to the Northern Pacific Railroad. On the other hand, 176,031 acres were classified as mineral land, either because the lands examined were found to contain valuable deposits of gold, silver, lead, phosphate or other important minerals, or because the geological and other indications warranted the prospecting of the lands for valuable minerals. Lands that are finally held to be mineral will remain in the public domain for entry and development by private enterprise. The potential value of the minerals included in these lands has not been fully estimated, but it is certainly very great.

UNIVERSITY AND EDUCATIONAL NEWS

The dean of the Wisconsin College of Physicians and Surgeons, Milwaukee, announces that an anonymous benefactor has given $5,000 to the maintenance fund of the college.

The trustees of Indiana University have appointed Dr. Charles P. Emerson as dean of the Indiana University School of Medicine, and head of the department of medicine. He will take up his residence in Indianapolis, the first of September, and will enter on his teaching and executive duties at the beginning of the fall term. It is definitely agreed that his first duties shall be to the university, and that consultations, to which his practise will be limited, shall be strictly secondary to these.

Dr. M. A. Rosanoff, since 1907 acting head of the department of chemistry in Clark University, has been made full university professor and head of the department.

Mr. Paul Hayhurst, assistant entomologist at the Arkansas Experiment Station, has been promoted to the full title of entomologist at the station and professor of entomology in the University of Arkansas with Mr. George G. Becker as his assistant. Mr. Hayhurst thus succeeds Dr. C. F. Adams, dean and director, who was formerly the entomologist.

Dr. Heinrich Biltz, associate professor at Kiel, has been called to the chair of chemistry at Breslau.

Professor Rössler, of Munich, has accepted a call to Jena as professor of pathologic anatomy.

DISCUSSION AND CORRESPONDENCE

THE PYTHAGOREAN THEOREM

TO THE EDITOR OF SCIENCE: In your journal for December 16, 1910, Dr. Northrup asks whether a dynamical investigation which he there gives is a proof of the Pythagorean theorem; and in the number for March 24, the question is discussed by Professor Deimel and Mr. Hersey. Looking at the question from the point of view of vector-analysis, or rather of the algebra of space, I would answer, Yes. Dr. Northrup starting from the principle of kinetic energy and certain other principles of dynamics deduces two expressions for the kinetic energy of the system shown in his diagram; and from the equivalence of these expressions he deduces the forty-seventh proposition of the first book of Euclid, commonly called the Pythagorean theorem; but he could with ease deduce the more general proposition (Euclid II., 12 and 13) which expresses the side of any plane triangle in terms of the other two sides and their included angle. His proof is merely the reverse of the following reasoning. I look upon the x, y, R, r and $-r$ of his diagram as vectors. The kinetic energy of the first mass is $\frac{1}{2}m(xW)^2 = \frac{1}{2}mW^2x^2$; and similarly that of the second mass is $\frac{1}{2}mW^2y^2$. But

$$x^2 = R^2 + r^2 + 2\cos Rr$$

and

$$y^2 = R^2 + (-r)^2 - 2\cos Rr$$

where $\cos Rr$ denotes the rectangle formed by R and the projection of r along R. Hence

$$\begin{aligned}\tfrac{1}{2}mW^2(x^2 + y^2) &= \tfrac{1}{2}2m(R^2 + r^2)W^2,\\ &= \tfrac{1}{2}2mR^2W^2 + \tfrac{1}{2}2mr^2W^2\end{aligned}$$

Here we pass from the one to the other expression for the kinetic energy of the system by means of the extended Pythagorean theorem; on the other hand, Dr. Northrup can deduce from the two expressions for the kinetic energy of the system the truth of this geometrical theorem.

This same principle that $E = \frac{1}{2}mv^2$ has an important bearing on the fundamental principles of vector-analysis: it places the orthodox quaternionist in a corner from which there is no escape. Because E is assumed in mathematical analysis to be positive and $\frac{1}{2}m$ is positive, it follows from the established principles of analysis that v^2 must be positive; consequently, to hold that the square of a simple vector is negative is to contradict the established conventions of mathematical analysis. The quaternionist tries to get out by saying that after all v is not a velocity having direction, but merely a speed. To this I reply that

$$E = \cos \int mvdv = \tfrac{1}{2}mv^2,$$

and that in these expressions v and dv are both vectors having directions which in general are different.

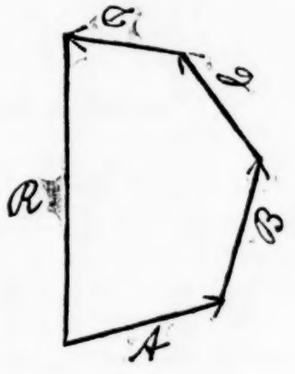

FIG. 1.

Recently (in the *Bulletin* of the Quaternion Association) I have been considering what may be called the generalization of the Pythagorean theorem. Let A, B, C, D, etc. (Fig. 1), denote successive vectors having any directions in space, and let R denote the vector from the origin of A to the terminal of the last vector; then the generalization of the Pythagorean theorem is

$$\begin{aligned}R^2 = A^2 + B^2 + C^2 + D^2 +\\ + 2\{\cos AB + \cos AC + \cos AD +\}\\ + 2\{\cos BC + \cos BD +\}\\ + 2\{\cos CD +\}\\ + \text{etc.}\end{aligned}$$

where $\cos AB$ denotes the rectangle formed by A and the projection of B parallel to A. The theorem of Pythagoras is limited to two vectors A and B which are at right angles to one another, giving $R^2 = A^2 + B^2$. The extension given in Euclid removes the condition

of perpendicularity, giving $R^2 = A^2 + B^2 + 2 \cos AB$. Space geometry gives $R^2 = A^2 + B^2 + C^2$ when A, B, C are orthogonal, and $R^2 = A^2 + B^2 + C^2 + 2 \cos AB + 2 \cos AC + 2 \cos BC$ when that condition is removed.

Further, space-algebra gives a complementary theorem, never dreamt of by either Pythagoras or Euclid. Let V denote in magnitude and direction the resultant of the directed areas enclosed between the broken line $A + B + C + D$ and the resultant line R, and let $\sin AB$ denote in direction and magnitude the area enclosed between A and the projection of B which is perpendicular to A; then the complementary theorem is

$$\begin{aligned} 4V = 2\{\sin AB + \sin AC + \sin AD + \} \\ + 2\{\sin BC + \sin BD + \} \\ + 2\{\sin CD + \} \\ + \text{etc.} \end{aligned}$$

Alexander Macfarlane
Chatham, Ontario

A bright aurora of September, 1908[1]

The finest display of the aurora borealis seen by the writer in Omaha during the last twelve years, took place on the night of Monday, September 28, 1908. Before describing its appearance, it may be of interest to mention the weather conditions that preceded and accompanied it.

No rain had fallen for about five weeks, the temperature during the day time had been unusually high, and strong winds had filled the air with disagreeable clouds of dust. The long duration of this state of the weather had become very monotonous. The expected clashing of a low from the northwest and of a West Indian storm from the southeast, had failed to bring any relief. Another week passed, and after an occasional cloudiness of the sky and an increasing humidity of the air had only tantalized this section of the country with unredeemed promises of moisture, the rain came at last and with it a rapid and great reduction of temperature, the thermometer fell from the eighties in which it had been hovering down to ten degrees above the freezing point. Monday, the day of the auroral display, opened with a temperature of about 40 degrees and a cold and disagreeable rain. It was still cloudy and misty at noon, but at about three o'clock the sky cleared, the wind came from the northwest, and the night began with a quiet, cloudless, cold and most transparent sky. An occasional glance at the heavens could detect no indications of an aurora. It was noticed rather suddenly at about 9:50 P.M. It then appeared as an arch extending from the northwest to the northeast horizon, and was about 8 degrees high on the meridian. Below the arch was a well-defined black space of uniform tint, which might easily have been taken for a bank of clouds. The arch itself was of a beautiful, soft, silvery whiteness, and seemed to be about 5 degrees in width. Its upper limit was not quite as distinct as its lower one. At this time there were no streamers of any kind, nothing but the arch. There was no moon to interfere with the display as it was seen from the observatory, and the city lights were also far enough away not to blind the eyes of the observer.

In about a quarter of an hour the scene changed. A few detached streamers now began to make their appearance, like the softened beams of search lights below the horizon. They were from about two or three to 20 or 30 degrees in length, and from one fourth to about 4 degrees in width. The short beams seemed to come directly out of the ground and were visible against or through the black space below the arch, and the longer ones passed visibly even through the bright arch itself. They did not seem to have any perceptible lateral motion, but they all seemed to come from the same vanishing point, which was estimated to be about 50 degrees below the horizon and on the meridian. The largest and broadest streamer was in the northwest, at the very end of the arch. It was about four degrees wide and 20 degrees long, and of a decided blood-red tint. A few of the other

[1] This excellent description was originally sent to the *Monthly Weather Review*, but is transferred to Science, as it belongs to cosmical physics rather than to climatology, to which the *Monthly Weather Review* is now confined.—Cleveland Abbe.

beams also showed the same tint, but most of them were of a faint silvery whiteness. They lasted from a few seconds to several minutes.

The arch gradually spread along the horizon until it covered 120 degrees or more, and at the same time ascended the meridian to the height of 15 or 20 degrees.

Then there were two parallel arches separated by a dark space, each arch and the dark space being about five degrees wide. Stars of the first three magnitudes could be seen equally through the bright and dark portions. Even in the group of the Hyades about Aldebaran the stars could be seen through one of the brightest portions of the display.

The upper arch then gradually broke up, its detached pieces appearing like floating clouds. They slowly drifted higher in the sky, until they seemd to be parts of a broken arch which extended from the west to the east points of the horizon. While these detached portions floated away, there seemed to be no streamers, as if streamers and broken arches could not exist together, but of this the writer is not certain, although he wrote down his observations at the first opportunity that presented itself the following morning. He himself observed the aurora for an hour until its gradual return to its first appearance, the dying out of its beams and the drifting of the luminous remnants of the arches gave him the idea that the display was nearing its end. A friend of his, however, kept up the watch for a second hour, and reports that the various stages described above repeated themselves after various intervals, and that some of the luminous clouds drifted as high as the zenith. How long the display lasted is not known, but the next morning at five o'clock the sky was completely overcast and there was no sign of an aurora.

On the following night there was another display of the aurora. It was noticed as early as 7:15 P.M., about an hour after sunset. The sky was not as transparent as on the preceding night, because the wind had been from the south all day. The arch was about the same, except that it had shifted bodily 20 degrees to the east. There were a few streamers of various lengths, but they died out quickly. Clouds began to form, and by 9:30 the whole sky was obscured. The aurora could, however, be seen to some extent through the clouds, and appeared like the lights of a distant city reflected from the clouds. It was still visible after ten o'clock. But there was no sign of it the next morning nor on the following night, although the sky was perfectly clear.

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QUOTATIONS

STATE SUPPORT OF MEDICAL EDUCATION

THE wave of reform in medical education moves steadily on, and of much significance is the part which state universities are taking in this reform. Slowly but surely colleges organized and conducted on the stock corporation basis are either obtaining connection with privately endowed universities or are giving way to the state supported university medical school. In the latter instance, the medical school is conducted as an integral part of the state's educational system. The latest instance is in Arkansas, where two independent medical schools, the College of Physicians and Surgeons and the University of Arkansas medical department, both of Little Rock, have been united. The school formed by this consolidation is to be controlled and financed by the University of Arkansas. This is but a repetition of what has already taken place in Indiana, Minnesota, Colorado, and the other states, where only one medical school remains in each instance, that being the medical department of the state university. In several other states, generous appropriations have been made for state university medical schools. This larger state support of medical education has another significance, however. It means that since the state is endeavoring to provide a good training for medical students it will not tolerate the turning out of poorly trained doctors by low-grade institutions. In fact, the inferior medical colleges even now are reading the handwriting on the wall. This accounts for the opposition, direct

or indirect, which they are making toward state endowments for medical education in Nebraska, Illinois and elsewhere. This opposition, however, will not be misunderstood and the progress for better standards of medical education has received too much impetus to be stopped by obstructions prompted by selfish interests. It is not only the right, but also the duty, of each state to provide a good training for those who are to have in charge the health of the people of that commonwealth as is the case in nearly all other countries.—*Journal of the American Medical Association.*

SCIENTIFIC BOOKS

Some Neglected Factors in Evolution. An Essay in Constructive Biology. By Henry M. Bernard, edited by Matilda Bernard. New York and London, G. P. Putnam's Sons. 1911.

The late Mr. H. M. Bernard has written several works which testify to a painstaking industry and a desire to take a broad view of the problems which arose in connection with his line of work. His more important contributions to zoology were volumes on the Apodidæ, the "Catalogue of the Madreporarian Corals in the British Museum" and his studies on the retina, and it was these last, especially, that were responsible for the ideas expressed in the volume under review, which has been edited from unpublished manuscripts by Mrs. Bernard. Bernard's studies of the retina led him to regard it as a syncytial network, and this conception rendered him skeptical as to the cell as the ultimate structural unit; it seemed to him to demand the postulation of a simpler unit, which might stand in the same relation to the cell as this does to a metazoan. This unit he termed a chromidium and described it as a particle of chromatin from which delicate linin filaments radiate, the stellate linin-chromatin mass being "embedded in a minute drop of some fluid albuminous matrix to the surface of which the filaments extend." By the growth and frequent partial division of such a unit a cell is formed, a unit of a higher grade and capable of being regarded as a synchromidium in which the chromatin material has become aggregated mainly at the center of the mass, the linin-filaments of the various component chromidia uniting to form a network and felting together to form the nuclear membrane. By this conception of the cell the author imagined that he had succeeded in reconciling two very divergent theories of cell structure, the chromatin particles being identical with Altmann's granules, while the linin-network produces the appearance which Bütschli had attributed to a foam structure. Just as the chromidium by imperfect division gives rise to the cell person represented by the protozoa, so this gives rise to individuals of a higher grade, the gastræal unit, represented by the cœlentera and the platyhelminths, and this to an annelidan unit, represented by the remaining groups of animals with the exception of man, who constitutes the final grade. And throughout each of these units there is continuity of structure, the linin-filaments forming a continuum throughout the entire organism to whatever grade it may belong, and the chromatin aggregating at the nodes of the linin-reticulum to form nuclei. Special condensations of the linin-filaments occur to form such structures as the cœlenterate mesoglœa and basement membranes in general, on the surface of which the nuclear nodes arrange themselves to form epithelia. Skeletal structures, from the radiolarian shell, the sponge spicule and the cœlenterate corallum to the vertebrate supportive tissues, also form in connection with it, and it gives rise to such structures as the nematocysts, cilia and nerve- and muscle-fibers.

This is, in brief, a statement of the first of the two main theses which the book seeks to establish. It is, however, difficult to perceive the necessity for such a unit as the chromidium. It stands in quite a different plane than the other infracellular units, such as biophores, gemmules, etc., that have from time to time been suggested, in that it is an independent unit of such a great complexity that the distinction between it and a cell, except

as regards volume, is by no means clear. Furthermore, it stands on a different plane from the supracellular units recognized by the author, in that these may be seen to form ontogenetically from a cell, but no one has yet observed the ovum developing by the division of chromidia. Indeed, one of the most obvious criticisms of Bernard's book is that it shows throughout a remarkable disregard of the facts of ontogenesis and histogenesis, so much so that it sometimes describes processes as its author supposed them to occur according to his theory, rather than as they actually occur. Further the same disregard has led the author to phylogenetic conclusions which, if they are to be regarded as essential conclusions from the theory under exposition, can only serve to render the reader skeptical as to its sanity. For instance, one is surprised to find that the Alcyonaria form a phylum altogether distinct from the other Anthozoa and related to the platyhelminths, that ctenophores are medusæ with the margins of the bell fused together, that *Sagitta* represents most accurately the primitive annelid and that the leeches may be regarded as representing the invertebrate types from which the vertebrate phylum has arisen!

Much more suggestive than the first is the second main thesis of the work, namely, that there has been a rhythm in evolution, each heightening of which corresponded with the appearance of one of the recognized grades of personality, that is to say, with the establishment of colony-formation of a higher grade. The differentiation and adaption possible for a cell-person is limited, but with the establishment of cell-colonies the potentialities become greatly increased. The author's treatment of this part of his subject is however again marred by a tendency to transcendentalism. Throughout all his grades of personality he finds continuity of structure combined with colony formation, and this theory demands continuity also in the colonies formed by his highest grade of persons, mankind. It is the linin-filaments that serve for the continuity; they are conducting paths for stimuli. But after all it is the stimulus that is the important item and not the material basis of transmission, and in human colonies we find transmission of stimuli without material continuity (telepathy), so that they too fall into line with the theoretical demands. This is much like eliminating the Cheshire cat and leaving only the grin, and why ant-colonies by the same process of reasoning should not be placed with man in the highest grade of persons, it is difficult to understand.

The book is interesting as a study in speculation, but it is doubtful if the speculations will find acceptance at the hands of biologists.

J. P. McM.

The Silva of California. By WILLIS LINN JEPSON. Memoirs of the University of California, Vol. II. Berkeley, 1910.

This magnificent folio volume does credit to the author and to the university which issues such a sumptuous account of the trees of California. It comprises 283 pages of text with 11 figures, 85 full page plates, 3 folded maps, subject and geographic indexes.

After a short preface, the author considers the geographic distribution of California trees, dividing the state into a number of provinces enumerated below. The Sacramento and the San Joaquin valleys form one province, which are essentially treeless, except for five stands or groves of the valley oak, or the interior live oak, while the banks of streams are lined with willows and cotton woods. The south coast ranges with an average height of 2,000–5,000 feet, are forested near the ocean with redwood, Douglas fir, tan oak, madroña and inland with other species, such as live and blue oaks, while Monterey pine and cypress are confined to an isolated arboreal island, constituting the Monterey peninsula. The north coast ranges are considered as to their climatic and floristic aspects with the redwood most prominent and the Douglas fir, tan oak, lowland fir, coast hemlock, Sitka spruce of secondary importance. The forest flora of the Sierra Nevada Mountains is enumerated, as well as that of

southern California, and the following zones are recognized, according to the classification of C. Hart Merriam: Sonoran, Transition, Canadian, Hudsonian and Boreal. A useful census of California trees is given where the species are not only arranged according to families, but the occurrence of each in the several previously mentioned phyto-geographic provinces is given. Jepson recognizes the difficulty of always deciding as to whether a species is a tree or a shrub by a brief account of the arboreous forms of shrubs, such as *Prunus demissa, Alnus tenuifolia,* toyon *Heteromeles arbutifolia,* etc. A list of the typically Californian species is added. Perhaps to the ecologist, the most interesting part of the memoir is the one devoted to the dendrologic characters of California trees. These are considered under the captions, mutilation and regeneration, seed production, architectural forms, wind-controlled tree forms, weeping trees, vanism in endemic species, natural hybrids, the "walnut-oak hybrids," teratology, leaf persistence, age of California trees and a bibliography with consideration of nomenclature.

After a synopsis of families, the author proceeds to minutely describe the characters, botanic habitat and history of each tree found in the Californian region and these full descriptions are supplemented by the plates of trees in the forest, as well as numerous plate figures illustrating the botanic characters of each tree admitted into the volume, as occurring within the confines of the state. Two maps illustrate the geographic distribution of the big trees (*Sequoia gigantea*) and a third is a general map of California showing the mountain chains, valleys and river systems of most importance to phytogeography. To make the work completely rounded, a subject index and a geographic index conclude the memoir. Altogether in a most thorough manner, Professor Jepson leaves little for the future botanist to consider from the purely systematic standpoint. The volume ably supplements the account of the California trees given in Sargent's "Silva," in Ludworth's "Forest Trees of the Pacific Slope" and in Britton and Shafer's "North American Trees."

John W. Harshberger
University of Pennsylvania

Hawaii and its Volcanoes. By Charles H. Hitchcock, LL.D., Emeritus Professor of Geology in Dartmouth College. Pp. viii + 314; 52 plates. Honolulu, The Hawaiian Gazette Co., Ltd. 1909. Second edition, with supplement of 8 pages, 1911.

The Hawaiian Islands have long attracted the attention of vulcanologists because nowhere else in the world can basaltic volcanoes of such majestic proportions be so easily studied as to both past history and the phenomena of active eruption. While but two centers can be described as now active, there are many others where erosion has revealed details of internal structure and petrographic constitution.

It is but natural that with nearly all explorers of the islands the liveliest interest has attached to Mauna Loa and Kilauea, where the spectacular phenomena of basaltic eruptions are displayed every few years and may be observed with ease and safety. Owing to the frequency of these eruptions during the last hundred years there is quite an extensive literature recording the observations of different outbursts, by geologists or laymen.

Kilauea in particular presents such an unrivalled opportunity for the study of the working of a basaltic volcano that several writers have given much space to recording its observed changes in historic times. Dana's well-known "Characteristics of Volcanoes" devotes nearly two thirds of its space to Kilauea and Mauna Loa, giving with considerable detail the recorded history of these volcanoes. Dutton, in his Geological Survey report on the Hawaiian Islands,[1] also quotes extensively from the published records of the principal eruptions of the active volcanoes.

It is clearly desirable that the eruptive history of Kilauea and Mauna Loa should be made as complete as possible, so that the student of present and future conditions at

[1] Fourth Ann. Rept. U. S. Geol. Survey, 1882–3.

these centers may have at his disposal all recorded observations of the phenomena of earlier outbreaks or periods of quiet. During a residence of several years in Hawaii, Professor Hitchcock has sought to complete the record of the active volcanoes by search of all available sources of information and by personal study of many features. The book under review is the result of this research. Its object is said to be "to describe correctly the phenomena connected with the discharges of molten lava from the two great Hawaiian volcanoes—Kilauea and Mauna Loa." "It is presumed that all the Hawaiian volcanoes throughout the archipelago have been developed in a similar manner. . . ."

From this point of view the work is the most satisfactory source of information on the subject, because compiled with care and with the aim of completeness.

The work is arranged in four parts. Part I., of 55 pages, is called Physiography of the Hawaiian Archipelago. Here may be found a brief but desirable sketch of the character and relations of the reefs and low islands which stretch away for more than a thousand miles to the northwest of Niihau, the most westerly inhabited island of the main group. In this part is found, also, the entire description, physiographic and otherwise, of Kauai, Oahu, Molokai, Maui and even of Hawaii, exclusive of the active volcanoes. Considerable space, relatively, is given to the stratigraphy of the water-bearing tuffs and coraline sands and limestones in the vicinity of Honolulu, to the study of which the author has given much attention.

Parts II. and III. are devoted, respectively, to the great volcanoes of Mauna Loa and Kilauea, and consist, as above indicated, chiefly of the compiled record of exploration and observation. Valuable as this record is, it serves to emphasize the fact that up to the present time little attempt has been made to study the phenomena displayed in other than a rather superficial manner. The actual physics of basaltic magma, the gaseous emanations accompanying it, the chemical composition of special magmas exhibiting certain phenomena, and the whole vast problem of volcanic energy, have scarcely been touched by observations thus far made at these volcanoes. It is to be hoped that some plan for more thorough investigations may be carried out. The field is certainly a most promising one.

Part IV. reviews The Hawaiian Type of Volcanic Action by summarizing the phenomena observed and citing the views of various authors as to their explanation. The comparison of Lunar and Hawaiian physical features by Pickering is specially noted.

In an appendix (17 pages) are given notes on earthquakes in Hawaii, the origin of the moon, the use of the spectroscope, a table of analyses of Hawaiian lavas, and biographical notes of explorers of the islands.

The second edition presents a supplement of eight pages, containing further data on certain eruptions, a criticism of W. T. Brigham's volume "The Volcanoes of Kilauea and Mauna Loa,"[2] and a list of errata, which is by no means complete.

The illustrations of this work are chiefly half-tone reproductions of photographs, which give an excellent idea of the volcanoes and their lava forms, and valuable sketch maps of the craters at several stages of development. The book is attractively gotten up, well printed, and is a credit to the enterprise of the Honolulu newspaper house which has published it.

WHITMAN CROSS

SPECIAL ARTICLES

THE PERMEABILITY OF LIVING CELLS TO SALTS IN PURE AND BALANCED SOLUTIONS

OVERTON performed experiments on *Spirogyra* and other plant cells and later upon various animal cells and came to the conclusion that only those substances penetrate which are soluble in lipoid. His criterion of penetration is simple and precise. If a solution plasmolyzes a cell and the protoplast does not subsequently expand if left in the solution it is clear that the dissolved substance does not penetrate. If it penetrated it would gradually

[2] "Memoirs of the Bernice Pauahi Bishop Museum," Honolulu, 1909.

increase the osmotic pressure inside the cell until the latter equalled the external pressure. In consequence the protoplast would expand and return to its original condition. Overton found that salts in general produce plasmolysis which is not followed by expansion of the protoplast. He therefore concluded that salts are unable to penetrate.

A repetition of Overton's experiments on *Spirogyra,* using the same criterion of penetration which he employed, has led me to the opposite conclusion. In my experiments with salts of NH_4, Cs, Rb, Na, K, Li, Mg, Ca, Sr and Al, the protoplast which is plasmolyzed and left in the solution expands again to its normal size, showing that all these salts readily penetrate the protoplasm.

I cite for illustration an experiment with NaCl for the reason that this is very generally employed as a plasmolyzing agent. Filaments of *Spirogyra* were placed in a .4M NaCl solution. Within two minutes the protoplasts of most of the cells were so far plasmolyzed that they no longer touched the end walls of the cells. Several of these were accurately sketched with the camera lucida and kept under continuous observation. In the course of ten minutes several of them had begun to expand and in thirty minutes all had expanded so as to completely fill their respective cells. To avoid the injurious action of the salt, the filaments were then transferred to .18M $CaCl_2$ solution and this was gradually diluted until its osmotic pressure was not greater than that of tap water. The cells were then transferred to tap water. They were examined the next day and found to be alive. On being placed in .4M NaCl they were plasmolyzed and afterward expanded as before.

Recovery from plasmolysis is about as rapid in KCl as in NaCl, while in $CaCl_2$ it is much slower. On the other hand, in CsCl it is much more rapid than in NaCl. In a subsequent paper the behavior in the various salts will be fully described.

Certain facts may be worthy of mention which tend to obscure these results and which may have caused them to be overlooked.

In the experiment just described the cells were transferred to a favorable solution as soon as expansion was complete. If this precaution be neglected and the cells be allowed to remain in the NaCl solution the injurious action of the salt soon causes the protoplast to shrink. In salts which are more toxic than NaCl this shrinkage may be more rapid and more pronounced. This shrinkage, which I have called false plasmolysis,[1] may also be produced by very weak (hypotonic) solutions and has nothing to do with plasmolysis but may simulate it in very misleading fashion. If the cells are not continuously observed but only examined at intervals the expansion of the protoplast may be easily overlooked, and the subsequent shrinkage may be easily mistaken for plasmolysis.

A further necessary precaution is the observation of the same individual cell during the course of the experiment. To provide for this and at the same time to keep the concentration of the solution unchanged, a variety of devices was employed which will be described elsewhere.

Cells which expand promptly if only slightly plasmolyzed may not expand at all if severely plasmolyzed.

Some kinds of *Spirogyra* are wholly unsuited for these experiments because they are quickly injured by the salts (or by distilled water made in metal stills if this be used for solutions) in such a way that they expand poorly or not at all.

Another proof of the penetration of a salt is illustrated by the action of $CaCl_2$ and NaCl. A portion of a *Spirogyra* filament was plasmolyzed in .2M $CaCl_2$ but not in .195M $CaCl_2$. A .29M NaCl solution has approximately the same osmotic pressure as a .2M $CaCl_2$ solution. But on placing another portion of the same *Spirogyra* filament in a .29M NaCl solution the expected plasmolysis does not occur and it is impossible to plasmolyze the cells until they are placed in .4M NaCl. It would appear that this difference between the behavior in $CaCl_2$ and NaCl is caused by the more rapid penetration of the latter. This supposition is in perfect accord with the con-

[1] Cf. *Bot. Gazette,* 46: 53, 1908.

clusions drawn from the rate of expansion, as stated above.

But the most striking proof possible of the penetration of the salt is afforded by the following simple experiment. By dividing a *Spirogyra* filament into several portions it was found that it was plasmolyzed in .2M $CaCl_2$ and in .38M NaCl but neither in .195M $CaCl_2$ nor in .375M NaCl. On mixing 100 c.c. .375M NaCl with 10 c.c. .195M $CaCl_2$ and placing other portions of the same filament in it, prompt and very marked plasmolysis occurred. Here we arrive at the extraordinary result that *by mixing together two solutions neither of which is able to plasmolyze we produce a solution which plasmolyzes strongly.* The experiment is so simple and striking that it is admirable for class-room demonstration.

It may be noted that in this experiment we add to a solution of NaCl a solution of $CaCl_2$ which is of much lower osmotic pressure. It is evident that although the addition of the $CaCl_2$ lowers the osmotic pressure, it nevertheless increases the plasmolyzing power of the solution considerably. Evidently it can do this by preventing the NaCl from penetrating the protoplasm or the two salts may mutually prevent each other from going in. The behavior of the cell indicates that in most cases the latter alternative is to be preferred. This will be fully discussed in another paper.

In the course of time the cells in the mixture of NaCl and $CaCl_2$ may expand, but this occurs very much more slowly than in pure NaCl. The appearance of the cell then shows in the clearest manner that it is not NaCl alone which has penetrated and caused the expansion, but rather NaCl and $CaCl_2$ together. This is evident from the fact that the effects which are characteristic of pure NaCl are entirely absent. But though they eventually penetrate they do so slowly and the effect of slow penetration is very different from that produced by sudden penetration and this may largely explain why they act as antidotes to each other.

It is evident that while the mechanism of antagonistic action may depend largely on the mutual action of the antagonistic salts in preventing each other from entering we must take into account their effect on the protoplasm within the cell as well as their effect on the plasma membrane.

Marine algæ give similar results.

The chief conclusions are as follows:

1. The usual method of determining osmotic pressure by plasmolyzing in salts of Na and K is very erroneous. Salts of Ca give more nearly the true osmotic pressure.

2. Since one substance may greatly affect the penetration of another it is unsafe to use the common method of adding a toxic to a non-toxic substance and judging the penetration of the former by the plasmolytic action of the mixture.

3. It is possible to state which salts penetrate and at what rate of speed, and also how various salts affect the permeability of the plasma membrane.

4. From these data we have a definite clue to the nature of the plasma membrane. Since all the salts studied penetrate it seems certain that the membrane can not be lipoid because these salts are not soluble in lipoid. Its behavior toward balanced solutions (together with other facts) indicates unmistakably that the membrane is proteid in nature.

5. Antagonistic salts such as NaCl and $CaCl_2$ hinder or prevent each other from entering. To such an extent is this true that by choosing solutions of NaCl and of $CaCl_2$ which are not quite strong enough to plasmolyze we produce by mixing them together a solution which plasmolyzes strongly.

The fact that these salts hinder or prevent each other from entering may explain why they act as antidotes to each other. But since they may eventually penetrate to some extent we must attach importance to their effect on the protoplasm within the cell as well as to their effect on the plasma membrane. These two effects may be very similar.

W. J. V. OSTERHOUT

INDIANAPOLIS MEETING OF THE AMERICAN CHEMICAL SOCIETY

IT has become almost monotonous to write that a meeting of the American Chemical Society was

the largest so far held, but again the Indianapolis meeting of the society has exceeded its summer record with 432 members and guests present.

The meeting was very successful, both in the matter of papers presented and social enjoyment. The hospitality of the local section knew no bounds and the members were treated to automobile rides, luncheons, smokers and concerts too numerous to be detailed. Interesting mementoes were given to each member that the Indianapolis meeting might not be forgotten. They consisted of watch fobs carrying the society insignia, steins carrying the society emblem in cobalt blue and gold, and bakelite cigar holders.

The meeting opened on Wednesday morning with general addresses by Charles Baskerville, on "The Chemistry of Anesthetics"; by W. Lash Miller, on "The Chemical Philosophy of High School Text-books," and by W. F. Hillebrand, on "The Quality of Platinum Utensils for Laboratory Purposes."

On Thursday evening a public lecture was given by A. D. Little at the German House, on "The Earning Power of Chemistry."

The banquet on Friday evening was addressed by Governor Marshall, of Indiana, and Ex-Vice-President Fairbanks and was graced by the presence of many ladies, including Mrs. Marshall.

The various manufacturing plants around Indianapolis threw open their doors to the chemists and in many instances gave special entertainment to them.

The papers presented at the meeting follow by title and by abstract so far as abstracts have been procured.

CHARLES L. PARSONS,
Secretary

Chemistry of Anesthetics: CHARLES BASKERVILLE, Ph.D., F.C.S., professor of chemistry, College City of New York. Printed above.

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

H. E. Barnard, *chairman*

B. E. Curry, *secretary*

Composition of the Drainage Water of a Soil with and without Vegetation: T. LYTTLETON LYON and JAMES A. BIZZELL.

Drainage water was collected from twelve large tanks, a description of which has previously been published. Each tank is slightly over four feet square and four feet deep with a capacity for about three and one half tons of soil. The drainage collected between May 23, 1910, and May 1, 1911, is taken as the basis for a study of the influence of vegetation on the removal of mineral matter in the drainage water.

Three tanks contained no plants, four were planted to corn and two to oats.

The nitrogen in the corn crop plus that in the drainage water from tanks cropped to corn amounted to 151 pounds per acre. That in the oat crop and drainage from the oat tanks amounted to 103 pounds per acre. There were, therefore, 48 pounds per acre more available nitrogen in the corn soil than in the oat soil. This is in line with the results of previous work by the writers, which indicated either that the corn plant has a stimulating effect on the process of nitrification, or that it utilizes to a large extent nitrogen in forms other than nitrates, or that both of these phenomena occur.

The bicarbonates were large in amount, but the much greater loss of basic material from the uncropped than from the cropped soil was removed mainly in the form of nitrate and not as bicarbonate. Any system of soil management which results in a decreased removal of nitrates in the drainage water will probably effect a conservation of bases in the soil.

The Influence of the Reaction of Solution on the Development of Wheat Seedlings: J. F. BREAZEALE and J. A. LECLERC.

Cold Storage and the Cryabiotic Point: W. D. RICHARDSON.

It is proposed to call the temperature below which the growth and reproduction of the lower microorganisms is prevented by the solid condition of the medium the "cryabiotic point," the derivation being obvious. The growth and reproduction of microorganisms implies increase in size, and such a growth is effectually resisted by such a solid medium as ice. The cryabiotic point for water would, therefore, be its freezing point 0° C. For media containing common salt, in which media bacteria thrive at temperatures much below 0° C., the cryabiotic point would be the cryohydric point of salt and water, or minus 22° C. For butter the cryabiotic point would also be approximately the cryohydric point of salt and water, or minus 22° C. For meats the cryabiotic point would be the temperature at which enough water had frozen out in the pure state to leave a solution so concentrated as to be a solid in the ordinary sense of the word.

In the past and current discussions on cold storage there has been much confusion owing to a failure to distinguish between temperatures used

for the storage of foods in which the foodstuffs were not solidly frozen, and hence in which bacterial activities were not absolutely stopped, although they may have been retarded, and those temperatures in which the foodstuffs were frozen so solidly that bacterial growth and reproduction became impossible. It is believed that the introduction of the expression "the cryabiotic point" will serve to distinguish between the two cases in discussions on the subject of cold storage.

The Composition of Canned Tomatoes: E. H. S. BAILEY and H. L. JACKSON.

The authors have made some examinations of quite a large number of brands of canned tomatoes on the market, especially with reference to the amount of solids in proportion to the juice. The solids in the juice are also determined as well as the ash. Some methods of standardizing canned tomatoes, by a determination of the solids and the ash are also discussed.

The Chemical Changes which take place during the Spoilage of Tomatoes, with Methods for Detecting this Spoilage in Tomato Products: R. F. BACON and P. B. DUNBAR.

Two New Pieces of Apparatus; (a) Apparatus for the Continuous Extraction of Liquids with Immiscible Solvents Lighter than Water, (b) A Compact Apparatus for Quantitative Determinations based on the Measurement of an Evolved Gas: R. F. BACON and P. B. DUNBAR.

The Action of Non-acid Foods on Tin Containers with Special Reference to Canned Shrimp: R. F. BACON and W. D. BIGELOW.

Determination of Tin in Food Products: EDWARD GUDEMAN.

A Chemical Study of Certain "Sandhill" Soils of South Carolina: T. E. KEITT.

The Volatile Acids of Corn Silage: ARTHUR W. DOX and R. E. NEIDIG.

The Arsenic Content of Shellac and the Arsenical Contamination of Food Products from that Source: H. B. SMITH.

The Solubility of CaO in Contact with Clay: B. E. CURRY.

Clay, known as fuller's earth, was kept in contact with water until equilibrium was established. From the solubility of the CaO it has been determined that the lime and clay form two series of solid solutions, the first extending from 0 per cent. to about 3 per cent. CaO and the second extending over a range from about 25 per cent. to 45 per cent. CaO.

A Short Method for the Determination of Soluble Arsenic in Commercial Lead Arsenates: T. O. SMITH and B. E. CURRY.

A 2-gram sample of lead arsenate is stirred continuously for 18 hours with 500 c.c. of water. When a correction is made for the solubility of lead arsenate the results are comparable to those obtained by the A. O. A. C. method in 10 days. When 500 c.c. of water is used the addition of 46 per cent. to the results give the same value obtained by the A. O. A. C. method.

By making a small correction for the solubility of lead arsenate the amount of soluble arsenic not combined with lead is obtained. The results obtained by the A. O. A. C. method include a large amount of arsenic combined with lead.

Methods of Estimating Fats in Tissue: W. KOCH.

For purposes of biological interpretation of analytical results it is necessary to distinguish between neutral fats and combined fats or lipoids. None of the present methods of estimating fat, including the official method, permit of this. The method of indirect estimation suggested by Koch and Carr obviates this difficulty. Further data on the comparison of this method with others were given and will be published in detail later.

It may be stated, however, that the Kumagawa and Suto method gives results which are below the actual quantity of total fatty acid on account of incomplete saponification of combined fats, especially in such tissues as liver and brain. The Koch and Carr method gives results which on account of certain sources of error, that it has not yet been possible to eliminate, gives results which are probably somewhat too high.

The Distribution of Organic Constituents in Soils: OSWALD SCHREINER and ELBERT C. LATHROP.

Dihydroxystearic Acid in Good and Poor Soils: OSWALD SCHREINER and ELBERT C. LATHROP.

Studies on Organic Soil Nitrogen: ELBERT C. LATHROP and BAILEY E. BROWN.

The Effect of Phosphorus Manuring on the Amount of Inorganic Phosphorus in Flat Turnip Roots: BURT L. HARTWELL and FREDERICK S. HAMMET.

As a result of chemical and microscopical examinations of flat turnip roots the percentage of inorganic phosphorus seems to be influenced more than that of the total phosphorus, by the amount of available phosphorus in soils; and that its determination therefore in the turnips is likely to be more useful for securing indications of the

relative phosphorus deficiencies in soils than the determination of total phosphorus which had heretofore been made use of at that station in ascertaining the relative phosphatic requirements.

Composition of the Timothy Plant at Different Stages of Growth: L. D. Haigh and P. F. Trowbridge.

The following table shows the per cents. of plant food constituents on the dry basis in the timothy plant at different stages. The per cent. of moisture is highest in the young timothy plant and shows a steadily declining value up to full ripening.

	Before Heading Out	After Heading Out	Blossoming	Ripe
Protein (N × 6.25).....	6.87	5.39	4.53	4.80
Ether soluble (fat).....	3.13	3.00	1.89	2.20
Crude fiber.....	26.69	28.28	38.10	27.43
Ash.....	7.50	6.30	5.24	4.58
Nitrogen free extract....	55.80	57.03	58.24	61.00

The plant food constituents other than carbohydrates have their highest percentage value before the head forms, as these are taken up most rapidly at this time. After heading out the carbohydrates are formed more rapidly, so that the percentage values of the other constituents decrease even while they are still being taken up.

The timothy plant, as a whole, takes up large amounts of nitrogen and mineral matter in the young stages but the amounts at any stage become less as ripening approaches. Nitrogen-free extract is formed at an increasing rate as the plant ripens.

The heads of the timothy increase in all its constituents during growth and ripening. As the seed ripens, a large increase of phosphoric anhydride occurs. This increase is not at the expense of some other part, but a distinct addition from the soil. From blossoming to the nearly ripe condition the phosphoric anhydride increases from 27.01 to 50.17 pounds per acre in the total plant.

The stalks increase in amount of total dry matter during growth and ripening, but a decrease occurs in the amount of nitrogen and ether soluble material during ripening. This is due, partly to dead leaves falling from the stem, and partly to transference of this material to the heads.

The bulbs increase in dry matter during growth, the amount then remains constant during ripening. The principal constituents added are nitrogenous matter and nitrogen-free extract, but no starch is formed in the bulbs at any stage. The potassium oxide and phosphoric anhydride remain about constant in amount from the time of heading to full ripening.

A large amount of potassium oxide especially is required for the growth of the timothy plant. One ton of air-dry timothy hay cut when nearly ripe will remove twenty-five pounds of potassium oxide and sixteen pounds of phosphoric anhydride from the soil.

The Detection and Determination of Small Quanties of Ethyl Alcohol, Methyl Alcohol and Formic Acid: R. F. Bacon.

The Determination of Malic Acid: P. B. Dunbar and R. F. Bacon.

The Detection of Benzoic Acid in Coffee Extract: Hermann C. Lythgoe and Clarence E. Marsh.

Coffee extract contains a substance which will give a reaction for benzoic acid. Acidify the sample, extract with ether, extract the ether with ammonia and evaporate the ammoniacal solution to a small volume and add manganese sulphate which will remove the disturbing substance. Filter, add ferric chloride and in the presence of benzoic acid a dark greenish precipitate occurs. Evaporate to dryness, sublime, take the melting point of some of the crystals and prepare the ammonium salt with the rest which will give the characteristic precipitate with ferric chloride if benzoic acid is present.

The Composition of Tincture of Ginger: H. C. Lythgoe and L. I. Nurenberg.

Several tinctures were made from Jamaica, African, Cochin and oleoresin gingers using alcohol of varying strength (approximately 95 per cent., 75 per cent., 50 per cent. and 25 per cent.), with the view of ascertaining the influence upon the composition. It was found that alcohol of 70 per cent. or more, especially in the case of Jamaica ginger, gave approximately the same amount of alcohol-soluble solids. The total and water-soluble solids increase as the strength of alcohol used decreases, and when the latter goes below 70 per cent. the alcohol soluble solids decrease. Of the tinctures made from oleoresin ginger, the one made from 95 per cent. alcohol was the only one which showed any appreciable amount of ginger resins.

The Volatile Acidity of Tragacanth and other Gums: W. O. Emery.

Akron (Ohio) Water: Home Treatment for Bath and Laundry: Charles P. Fox.

(*To be continued*)